# PART 12

# PARTICULAR ELECTRICAL PLANT REQUIREMENTS

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**PART 12**

# PARTICULAR ELECTRICAL PLANT REQUIREMENTS

## 12.1 Introduction

The specific design and performance requirements for all electrical equipment are given in this part of the Specifications. The Requirement specified shall be fully met with by the Contractor. In case of any deviations, the Contractor shall bring out the same in "Schedule of Deviations from Particular Requirement" failing which shall be considered that the Contractor fully complies with these requirements. General Requirement of electrical equipment is covered under Part-6 of this specification. Tender drawings will be provided for **reference purpose only**.

## 12.2 Scope of works

The scope of works for STP / TSPS includes design, manufacture, testing at works, supply and delivery at site, unloading and storing the equipment at site of installation, installation, testing and commissioning of the following equipment at site.

11kV Metal enclosed Switchboards, 11kV/0.433kV transformers, 415V Diesel Generator Sets with Acoustic Enclosure & AMF Panel, 415V Metal enclosed switchboards / distribution boards / motor control centres, 415V capacitor banks with APFCR panel, Battery, Battery charger, DC Distribution board, Variable Frequency drives, non-segregated bus ducts, Lighting system, Power & control cables, Cable carrier system, Earthing & Lightning protection system.

All equipment / items shall be of makes as specified in the list of preferred makes. Various equipment/ items shall conform to latest applicable standards specified and latest amendments. In case of Conflict between standards and this specification, this specification shall govern.

## 12.3 Existing Power Supply Arrangement

There is an existing 11kV incoming power supply available at site near existing plant transformer yard received on a Double Pole structure through 11kV overhead line from BESCOM substation. 11kV supply is then converted into 11kV underground cables and connected to 11kV metering cubicle.

For the upgradation works upto 11kV metering, BESCOM shall be making necessary modifications at the two-pole structure, 11kV isolators, LA's, RMU, 11kV metering and interconnecting cables. This work shall be executed by BESCOM through provisional sum.

The Contractor's scope for STP / TSPS starts from the outgoing of corresponding 11kV VCB / 11kV Metering panel provided by BESCOM near two pole structure and shall cover all equipment / items as given above in clause 12.2, Scope of works and shall also include the following: -

- Liasoning with BESCOM for getting construction power supply, making new power supply agreement for the plant and getting final clearance from CEIG for complete Electrical system.
- Dismantling, Removal & shifting as per client instructions of all the existing electrical equipment i.e. existing transformers, HT panels, LT panels, cables, lights, battery etc. and all the electrical connections between the electrical system.
- Works related to modifications in existing Electrical substation HT Room, LT Room & MCC room sizes (if envisaged) for accommodation of electrical panels, extension of cable trenches, clearing of debris in existing cable trenches, making suitable changes in the buildings for bus-duct, cable tray entry, pipe sleeves, cable pull pits, light fittings etc.
- Existing transformer yard shall be utilized for installation of 2 nos. of new transformers with necessary modifications for changing location of door/rolling shutter/windows/ventilators / bus duct entry / Cable entry / cable pull pits of the LT room/HT room shall be as per the requirement & standard norms.
- New transformer yard for installation of 2 new transformers, new 11kV Panel room, new LT panel room, new battery room shall be planned near the proposed Air Blower Building.
- Existing DG room near CCT shall be demolished, and 1 Nos. of new DG sets along with exhaust stack shall be installed outdoor with a shed.
- 1 No. outdoor type DG set shall be planned near the proposed Air Blower LT panel room with a shed.
- Works related to existing transformer yard i.e. clearing of bushes, jelly stone laying, earthing pits and strips, providing gate and fence etc. is included in contractor scope.
- All complete electrical works as mentioned in clause 12.2 for the new buildings and the existing buildings and entire plant area.

## 12.4 Power supply arrangement

The power supply for plant upgradation works of STP at 11kV, 3 phase, 50 Hz shall be provided by altering the existing power supply arrangement.

The incoming 11kV (overhead line / underground cable) supply from BESCOM shall be terminated at outdoor two pole structure / RMU. Outgoing terminals of the two-pole structure / RMU shall be connected further to outdoor 11kV metering unit to be located near two pole structure. The outgoing cable from the metering unit shall be connected to incomer of 11kV Metal Enclosed Switchboard at STP/TSPS.

The outgoings of the 11kV Metal Enclosed Switchboard shall feed two numbers (4 Nos.) of 11/0.433kV Distribution Transformers.

- 2 Nos. of 11/0.433kV Distribution Transformers shall feed load of Process Air Blower.
- 2 Nos. of 11/0.433kV Distribution Transformers shall feed balance load of the plant.

415V PCC / Main LT panel for Process Air Blower shall be provided with 2 nos. of incomers from transformers & 1 no. of incomer from DG with an interlock. Further power to the air blower loads is provided from the outgoings of the 415V panel.

415V PCC / Main LT panel for balance load of plant shall be provided with 2 nos. of incomers from transformers & 1 no. of incomer from DG with an interlock. Further power to the plant loads is provided with various MCC panels located in MCC rooms from the outgoings of the 415V panel.

Refer the Single Line Diagram for the Electrical Works at Existing 6 MLD STP, (Sh 1 of 5 to 5 of 5) Drawing Nos. TCE.12975A-EL-4001-AU-40011. The provided Single Line Diagram and the power distribution scheme are for **reference purpose only**. Contractor to provide the electrical system based on his design and with reference to the tender specifications.

## 12.5 General Design Criteria for STP / TSPS

All electrical equipment shall be rated for 45˚C design ambient temperature. The installation shall generally conform to Indian Standards / IEC.

The following factors shall be considered for proper selection of electrical apparatus or equipment for areas where flammable gas or vapours may rise.

**(a) Area classification**

The classification of area shall be as per IS 5571 & IS 5572, based on the degree of probability with which explosive concentrations of combustible gas or vapour may arise in installations in terms of both the frequency of occurrence and probable duration of existence on each occasion.

(i) Zone 0 – In which an explosive gas/air mixture is continuously present or present for long periods.

(ii) Zone 1 – In which an explosive gas/air mixture is likely to occur in normal operation.

(iii) Zone 2 – In which an explosive gas/air mixture is not likely to occur in normal operation and if it occurs, it shall exist only for short periods.

**(b) Gas Group Classification**

The characteristics of the gas or vapour involved in relation to Igniting current or minimum ignition energy in case of installations of intrinsically safe apparatus or maximum experimental safe gap data in case of installations for flame proof enclosures as per IS 2148.

**(c) Temperature Classification**

The Ignition temperature of the gas or vapour involved, or the lowest value of ignition temperature if more than one combustible material shall be present.

The maximum temperature of any unprotected surface of electrical equipment shall not exceed the Ignition temperature of gas or vapour. For electrical apparatus, no margin of safety need be applied between maximum surface temperature and ignition temperature. The Ignition temperature of combustible gases and vapours are measured in accordance with the test method prescribed in IS 7820.

(d) **Environmental conditions** in which the apparatus shall be installed. Apparatus and its component parts shall be constructed so as to guard against electrical and mechanical failures in the intended conditions of use.

The selection of type of protection of electrical equipment for the different zones of Hazardous areas shall be made in accordance to Clause 6, Table -1 of IS 5571.

All electrical equipment installed in hazardous areas shall confirm to selection of equipment and installation guidelines of IS 5571.

## 12.6 HV System

| | | | | |
|---|---|---|---|---|
| a) | Nominal voltage | | 11kV | |
| b) | Number of phases | | 3 | |
| c) | Frequency | | 50 Hz | |
| d) | Connection | : | 3 Wire | |
| e) | Maximum Fault Level/current | : | 500 | MVA (26.25kA) |

## 12.7 LV System

### (a) General Supply

| | | | |
|---|---|---|---|
| a) | Voltage: | : | 415 V nominal |
| b) | Frequency: | : | 50 Hz |
| c) | Connection | : | 4 wire |
| d) | No load transformer voltage | : | 433 V |
| e) | System earthing | : | Solidly earthed |
| f) | Maximum fault level/current | : | 36 MVA (50kA) |

All Plant shall, unless otherwise specified, be capable of continuous operation at a voltage level in the range of 90% to 110% of the relevant nominal voltage and a frequency variation of plus 5% minus 5% with a maximum combined tolerance of 10%.

**(b) AC Control, Lighting and Space Heating**

- Voltage: 240 V
- Phases: 1
- Frequency 50 Hz
- Connection 2 wire (Phase & Neutral)

**(c) DC Control, Protection and Alarm**

- Voltage: 110 V
- Phases: 1
- Connection 2 wire (unearthed)

## 12.8 HV Metal Enclosed Switchboard

### 12.8.1 11kV Indoor Switchboard

11kV Switchboard shall be indoor, floor standing, sheet metal enclosed with IP4X degree of protection, with draw out type vacuum circuit breakers for incoming & outgoing feeders, control & protection. The switchboard shall be rated for a fault current not less than 26.25 kA (rms). All protective relays shall be numerical type.

## 12.9 Distribution Transformer

### 12.9.1 11/0.433kV Transformers

The transformers shall be outdoor type, ONAN, 11/0.433 kV, 3 phase, 50 Hz, two winding, Dyn11 with solidly earthed neutral with OLTC.

The transformers shall be sized considering 15% contingency of total working load while arriving at the final capacity of transformers. Two numbers of transformers shall be provided in each load location such that under normal condition, each transformer shall be loaded up to 50% and in case of failure of any one transformer, the healthy transformer shall have capacity to take entire load so as to have 100% standby.

The transformers shall be designed such that at any point of time maximum loading (including Contingency Capacity) on any single transformer shall not exceed 85% of full load capacity. Maximum rating of the transformer shall be limited to 2500kVA.

## 12.10 System Protection

Numerical relay-based protection system for various parts of the power supply system shall be proposed. The following protection systems shall be used:

**(a) 11 kV Incomer Feeder**

- Instantaneous phase over current protection
- Instantaneous earth fault protection
- Inverse definite minimum time phase over current protection
- Inverse definite minimum time earth fault protection
- Potential transformer fuse failure protection
- Under voltage protection
- Negative phase sequence protection
- Breaker failure protection
- Inrush protection

**(b) 11 kV Transformer Feeder**

- Inverse definite minimum time phase over current protection
- Inverse definite minimum time earth fault protection
- Instantaneous phase over current protection
- Instantaneous earth fault protection
- Standby earth fault Protection
- Thermal overload protection
- Inrush protection
- Breaker failure protection

- Winding temperature high, alarm &trip
- Oil temperature high, alarm &trip
- Buchholz relay alarm and trip
- Magnetic oil level gauge alarm
- Restricted Earth Fault relay to be provided for Transformer rating 2MVA and above
- Pressure relief valve alarm & trip
- Oil surge relay trip
- Alarm annunciation with connectivity (communication port RS485) to PLC

**(c) 415V Incomer Feeder**

- Overload, Earth fault and short circuit protection
- Under voltage Protection

**(d) LV Motors**

**(i) Motors less than 15kW**

- Motor Protection relay with following protection
- overload protection by three phase thermal (bimetal) relay
- Single phasing preventer
- Motor Protection Circuit Breaker (MPCB)

**(ii) Motors 15kW up to 75kW**

- Electronic motor protection relay providing the following protection
- Overload
- Earth fault
- phase currents out of balance
- Single phasing preventer
- MCCB

**(iii) Motors above 75kW**

- Comprehensive motor protection relay providing the following protection
- Thermal Overload
- locked rotor
- Phase Over current (50/51)
- Earth fault (50N/51N)
- Over voltage & under voltage
- phase loss/reversal
- Negative sequence
- Protection for repeated and prolonged starts
- restart inhibition
- Single phasing preventer
- Temperature Monitoring (Alarm & Trip)
- ACB/MCCB

Note: - RTD's of Winding and Bearing Temperatures of Pumps / Motors shall be monitored through Temperature Scanner Indicators.

**(iv) Pump Drives**

All pumps shall be provided with the following additional protection, as per requirement:

- Dry run protection
- Temperature protection, (Submersible pumps)
- Moisture entry protection. (Submersible pumps)
- Over pressure (positive displacement pumps)

**(v) Blowers**

Blowers shall be provided with the following additional protection:

- Over pressure

**(vi) Rotating Arm Drives**

Rotating arm drives shall be provided with the following additional protection:

- motion detectors
- Over torque detectors

**(vii) Valve Actuator Drives**

Valve actuator drives shall be provided with the following additional protection:

- Over torque detectors

## 12.11 Switchgear Equipment / Instruments

**(a) 11kV Feeders (Incomer and Transformer feeders)**

- Ammeter for all 3 phases
- Voltmeter with selector switch
- KW meter
- KWh meter
- KVARh meter
- Frequency meter
- Power factor meter.
- Digital Multifunction meter with RS 485 connectivity for measuring Harmonic contain (%THD), total wattage, power factor with all electrical parameters

**(b) 415V Incomer Feeders**

- Ammeter with selector switch
- Voltmeter with selector switch
- KW meter

- Digital Multifunction meter with RS 485 connectivity for measuring Harmonic contain (%THD), total wattage, power factor with all electrical parameters

**(c) 415V Motor Starter Feeders**

-Ammeter with selector switch

-Voltmeter with selector switch

-KW meters for Motor feeders more than 75kW

-Multifunction meters with facility to extract historical data for Process Air Blower Feeders and for measuring Harmonic contain (%THD), total wattage, power factor with all electrical parameters

-DOL Starters for motor feeders less than or equal to 5.5kW

-Star-Delta Starters for motor feeders above 5.5kW and up to 75kW

-Line/Neutral Soft Starters for motor feeders above 75kW

## 12.12 Standby Diesel Generator Sets

There shall be 2 Nos. number 415V, 50Hz Standby Diesel Generator Set with Acoustic Enclosure and AMF panel at each STP/TSPS and ISPSs locations. The capacity of the Standby Generator shall be sized for power back up for all the loads which are required for continuous operation of the corresponding STP/TSPS during main power failure and 10% Contingency over these loads shall be considered while sizing the DG Sets.

## 12.13 Automatic Main Failure Panel

AMF (Automatic Main Failure Panel) panel shall be provided for the Diesel Generator Set.

In case of main failure detected by an under-voltage relay mounted in the AMF panel, the main breakers (receiving the main power from BESCOM) shall be switched off under auto mode. Consequently, the standby generator starts in the auto mode. After the generator set reaching the rated speed and rated voltage, the generator circuit breakers shall be switched on to feed Diesel Generator power to the AMF panel. On restored main supply, the reverse sequence of the above shall be followed for the mains supply to feed power to the loads as in normal condition.

## 12.14 415V PCC / MCC

415V PCC/MCC shall be floor standing, sheet steel enclosed with IP 54 Degree of Protection, Form–IV enclosure as per IS 8623 complete with Air circuit breakers/MCCB's /MPCBs, Control & Protection. The PCC / MCC shall be rated for a fault current not less than 50kA (rms) for 1 sec.

All Motor Feeders in the MCC Panels shall have Contactors, Start-Stop Pushbuttons, ON-OFF-Trip indication and OLR reset button. All starter feeder shall have with Type-2 coordination and Contactors have AC3 duty.

### 12.14.1 Local Control Panel (LCP)

For each motor:

- Local / Off / Remote selector switch to be provided. 3 Push buttons "START / STOP / EMERGENCY STOP" shall be provided.
- Start push button operates only when the switch on LCP is in "Local" position.
- Stop push button shall operate only after pre-determined requirement of closing the delivery valve either in Local mode or Remote mode for 90kW and above pump motors.
- Emergency Stop push button operates irrespective of the position of the selector switch.

When the selector switch on LCP is in "LOCAL" position, the motor shall be operated by push buttons on LCP and shall take into account only the specific fail-safe controls of the equipment (electrical protections, low level for a pump). When the selector switch on LCP is in "REMOTE" position the drive shall be operated from PLC

Motorized valves shall be with fully integrated control Actuator. The actuator comes with integrated:

- One Selector switch "Remote / Local"
- Control switch for: OPEN / CLOSE / STOP.
- Local Control cubicle with remote operation from PLC with position feedback.

### 12.14.2 Operation Logic of Switchgears

**Operation Logic of 415V Metal Enclosed Switchboard at STP & Air Blower Substation:**

- At normal condition, both the Incomers shall be in Closed Position and the DG Incomer & Bus coupler shall be in Open Position.
- If any Incomer fails the faulty Incomer shall be in Open Position, the Bus coupler and the healthy Incomer shall be in Closed Position.
- In Case of Power Failure, DG Incomer & Bus coupler shall be in Closed Position and the Mains Incomer shall be in Open Position. The plant loads shall run on DG Set.

### 12.14.3 Capacitor Banks and Power Factor Correction

The LT capacitor banks provided shall be of bus connected type with Automatic Power factor correction, the system shall be designed such that a power factor of not less than 0.98 shall be maintained.

Automatically controlled multistage power factor correction shall be provided. 2 Nos. PFC panels providing no less than 12 number PFC stages per panel shall be provided each connected to one bus section of the LT Switchboard. The PF on each bus section of the board shall be monitored and corresponding PFC capacitors switched in and out automatically in discrete stages to maintain a set point PF value.

Each panel shall be configured such that no PFC capacitor stages shall operate when the standby generator is powering the side of the distribution board to which shall be connected. Reactors shall be provided for the protection of capacitors.

MCCBs, Switches, Contactors shall be suitable for making and braking current of the capacitors. The Panels shall be floor standing, sheet steel enclosed with relevant degree of Protection.

### 12.14.4 Variable Frequency Drives

Following minimum loads shall be provided with Variable frequency Drives with communication port:

- TSPS Pumps
- Process Air Blowers
- Mixed Liquor Recycle Pumps
- Return Activated Sludge Pumps
- Centrifuge Feed Pumps
- Dewatering Centrifuges
- Alum Dosing Pumps
- Polymer Dosing Pumps

### 12.14.5 DC Power Supply

DC Power supply shall be provided for protection and control in 11kVand 415V Switchgears.

A Conventional system operating at 110V DC using maintenance free rechargeable Ni-Cd batteries shall be provided and shall be complete with battery, battery charger with boost & trickle charging facilities, necessary controls, indications and DC distribution board.

## 12.15 Cabling

**(a) 11kV Power Cables**

The cables shall be 3 core, 11kV (UE), XLPE type with stranded aluminium conductors & GI armouring. Minimum size of cable shall be selected based on the short circuit current considerations.

**(b) LV Power Cables**

LV power cables shall be 1.1kV XLPE type with stranded Aluminium/Copper Conductors with GI armouring for the following sizes:

(i) ≤ 6 Sq.mm. - Stranded Copper conductors with GI armouring cable

(ii) > 6 Sq.mm - Stranded Aluminium conductors with GI armouring cable

No. of cores shall be as per requirement.

**(c) Control Cables**

Control cables shall be 650/1100V, XLPE with stranded copper conductors and GI armouring. No. of cores shall be as per requirement. Minimum size of core shall be 1.5 Sq.mm.

**(d) Cable Rating**

All power cables shall be sized for continuous current carrying capacity and permissible voltage drop at an ambient temperature of 45 degrees C. Due consideration shall be taken of cable grouping, method of installation and local variations in ambient conditions. Further, for cables controlled by circuit breakers, due consideration shall be given to the fault level.

HV and LV cables shall be sized for a minimum fault clearance time of 1 second for incoming feeders and 0.5 second for equipment feeders

For all LT Cables, the voltage drop in the cables between the transformer and the switchgear (PCC) or between PCC and MCC for full load current shall be limited to 2%. Further the voltage drop in cables between PCC/MCC to Motor terminals for full load current shall be limited to 3%. The Total Voltage drop transformer secondary to motor terminal shall be limited to 5%.

Under motor starting conditions the corresponding voltage drop shall not affect the operation of the motor controls or the ability of the motor to start and run effectively and in any event shall not exceed 10%. The Contractor when sizing cables for the remote operation of shunt trip coils shall take due account of the voltage drop caused by the momentary current surge taken at the instant of energisation.

**(e) Cable Installations**

Heavy duty galvanized iron cable tray and ladder racking shall be used for cable support systems. These shall be used to route cables along walls, below beams and within cable trenches. Cables shall be securely fixed to the support systems. Bundling of cables shall be permitted where allowance for this practice has been made while sizing the cables.

Cables of different categories shall be installed to maintain satisfactory clearances for safety and in order to reduce the possibility of electrical interference. The following Table details the distances in mm that shall be maintained between the different categories of cables.

**Table of Separation Distances between different Categories of Cable.**

| Cable Category | HV Power | LV | C&I/ | Telecomm |
|---|---|---|---|---|

| | | Power | Protection | |
|---|---|---|---|---|
| HV Power | N/A | 300 | 600 | 600 |
| LV Power | 300 | N/A | 300 | 300 |
| C&I/Protection | 600 | 300 | N/A | 100 |
| Telecomm | 600 | 300 | 100 | N/A |

**(f) Cable Numbering**

All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosion resistant label. Cables of different categories shall be tagged with the following subscripts and a three-digit number.

- HV power HV-P_ _ _
- LV power P_ _ _
- Control C_ _ _
- Instrumentation I_ _ _
- Protection PR_ _ _
- Telecommunication T_ _ _

## 12.16 Building Services

### (a) Lighting

All internal and external areas shall be provided with lighting. The illumination levels to be achieved shall be as follows:

**Illumination System**

Latest version of related IS standards, NBC and National Lighting Code (NLC) shall be referred for designing Illumination for different areas.

All lighting design shall be carried out on DIALux latest version or OEM specific software.

The basis of design shall be based on the following lighting engineering criteria, as per relevant standards or specified herewith:

a) Lighting lux level

b) Luminance distribution

c) Glare restriction

d) Direction of incidence of light and shadow effect

e) Colour appearance and colour rendering of the light source

f) Uniformity

Selection of Luminaries and Illumination Level: The following luminaries shall be provided for various areas in order to achieve the average luminance as per various relevant lighting standards or those indicated below:

| **Sl. No.** | **Area** | **Type of Light Fittings** | **Lux** |
|---|---|---|---|
| 1 | Pump house | Surface Mounted LED batten | 200 Lux |
| 2 | Battery room | Corrosion proof - Industrial type LED batten | 150 Lux |
| 3 | Machinery service area | Industrial type LED batten | 200 Lux |
| 4 | Offices and conference rooms | LED Surface mounted decorative down lighter fitting with polycarbonate cover | 300 Lux |
| 5 | Switchgear room/MCC, DG room | Industrial type LED batten | 250 Lux |
| 6 | Control rooms/ SCADA room | LED Surface mounted decorative down lighter fitting with polycarbonate cover | 300 Lux |
| 7 | Chemical and general stores | Industrial type LED batten | 150 Lux |

| | | | |
|---|---|---|---|
| 8 | Chemical plant room | Anti-corrosion Industrial LED batten | 200 Lux |
| 9 | Cable basement | Industrial type LED batten | 100 Lux |
| 10 | All other indoor areas | Industrial type LED batten | 100 Lux |
| 11 | Outdoor platforms and walkways | LED Bollard post tops and Uplighter | 50 Lux |
| 12 | Building entrance | LED Surface mounted decorative down lighter fitting with polycarbonate cover | 100 Lux |
| 13 | Outdoor plant areas | LED Flood lights | 20 Lux |
| 14 | Outdoor transformer yards<br>- General<br>- On equipment | Industrial type LED batten | <br>20 Lux<br>30 Lux |
| 15 | Roads (secondary) | Industrial type LED batten | 20 Lux |

Ceiling fans shall be provided in offices, control rooms and they shall be connected to local lighting circuit.

The internal lighting installation shall be installed using single core, PVC insulated copper cable enclosed in galvanized iron conduit. Lighting in external areas shall be installed using multicore armoured XLPE cable

Following factors shall be considered while arriving at the utilization factor to determine the number of fixtures for each area/building:

a) Maintenance Factor

- Indoor Area Lighting with LED Luminaire : 0.7
- Outdoor Area Lighting with LED Luminaire : 0.6

b) Reflection factor for Indoor Lighting to be considered are as follows:

- Ceiling : 0.5
- Walls : 0.3
- Floors : 0.1

c) However, Reflection factor can be selected based on the Color of the wall and Ceiling as given below:

- White and very light colors : 0.7
- Light colors : 0.5
- Middle tints : 0.3
- Dark colors : 0.1

d) Room index at applicable surface reflection factors need to be considered.

e) The working plane shall be considered at 0.75 m from the floor level.

f) Uniformity factor shall be considered as per National Lighting code/ NBC/ IS code.

The power supply for lighting shall be distributed from Lighting Distribution Boards and feeder pillars.

For street lighting, cabling shall be done with 4C armoured cable such that alternate fixtures are different phases.

Street lighting shall be Centralized, on grid solar power supply system suitable for power supply to required number of streetlights to illuminate the complete treatment facility. Necessary interlocks shall be provided between main supply and solar supply in such way that solar energy shall be used always and switchover to EB source automatically when there shall be no solar energy available.

- Solar module shall convert solar energy into electrical energy and store into the battery. During the night time stored energy shall be converted to AC using efficient inverter and shall be supplied to the street lights. The system shall be powered from the normal grid supply in case of cloudy days or in case of insufficient day light to charge the battery. Roof of "**ADMIN BUILDING"** of STP area can be used for solar cell.

**(b) Emergency Lighting**

Self-contained chargeable type emergency luminaires shall be provided in all internal premises except Substation building and the Contractor shall maintain minimum illumination level of 5 lux. These luminaires shall automatically illuminate in the event of a power failure and provide a minimum level of lighting for approximately 3 hours. They shall automatically recharge on the return of mains power.

**(c) Ventilation & Exhaust Fans (3 phase)**

Variable speed ventilation ceiling fans & exhaust fans shall be provided in offices and switchgear rooms as per requirement. One Ceiling fan of 48" size shall be provided for each 10 $m^2$ or part thereof of the area concerned.

Where fitted ceiling fans shall be connected to the local lighting circuit.

**(d) Small Power Outlets**

Switched single phase three pin 5 A and 15A receptacles shall be provided throughout. In offices and control rooms they shall be modular decorative type and industrial type in all other areas for single and three phase sockets. All outlets for domestic pump, dewatering pump, submersible sump pump shall be provided with local starter panel or control cubicle. All metal clad sockets shall be provided with suitable metal clad plug.

Unless required to be provided in greater numbers to power specific Plant items the number of such outlets shall be as follows:

- 5 A type one outlet per 5 m or part thereof of perimeter in offices and laboratories
- 5 A type one outlet per 20 m or part thereof of perimeter in all other areas
- 15 A type one outlet per 20 m or part thereof of perimeter in offices and laboratories
- 15 A type one outlet per 20 m or part thereof of perimeter in all other areas.

**(e) 3-Phase Power Outlets**

32A switched (MCB) three phase and neutral receptacles shall be provided in plant areas where appropriate i.e. adjacent to areas where flooding is likely (to permit the use of portable sump pumps) or where other portable equipment is likely to be used in the operation of the treatment plant. The Contractor shall install ten such outlets at various locations throughout the treatment plant.

The location of outlets shall be approved by the Engineer. The spacing of 5A and 15A outlets shall be arranged to suit the intended location of equipment, desks etc.

Receptacles for outside areas shall have a degree of protection of IP 65.

## 12.17 System Earthing

An earthing system comprising earth electrodes and conductors shall be established for Sewage Treatment Plant.

The earthing system shall be designed to give a combined earth resistance value of not greater than 1 ohm. In order to be sure of obtaining suitable final values, soil resistivity shall be measured at the various sites during the detailed design phase of the work.

In outdoor substation areas the main earth electrode conductors shall be located, to ensure potential gradients occurring at the surface during fault conditions are kept within allowable limits.

Materials used for earth electrodes shall be designed to suit the ground conditions and shall either be plain mild steel or Galvanised steel.

The system shall be designed for the following maximum earth fault currents. These values shall be confirmed at the detailed design phase.

- **11kV system 26.25 kA.**
- **415V system 50 kA.**

The fault clearing time shall be taken as **one second** for the 11kV and 415V systems.

The maximum temperature allowed for steel welded joints shall be taken as 500 degrees C with an ambient of 45° C. Main equipotential bonding conductors shall be galvanised steel.

Circuit protective conductors shall comprise either the armouring of the supply cable or, for major loads such as main switchboards and large drives the supply cabling plus an additional suitably sized single core copper cable.

All earthing pits shall be of treated pits only.

Transformer and DG Set neutral earthing shall be of copper earthing.

The neutral point of the 11/0.433 kV transformer secondary windings shall be solidly earthed.

## 12.18 Qualification Criteria for Electrical agency/vendor for Design, Supply, Program, Execution and Commissioning of Electrical Works

The contractor shall submit the following documentation as part of credentials submissions for the electrical works for design, supply, and program, execute and commission the electrical works.

The agency which shall design, supply, program ,execute and commission electrical equipment system (HT & LT) on a minimum, shall be operating under an accredited ISO 9001:2015 system and shall be a Class-A electrical contractor with state PWD or central PWD, with a minimum of 10 years' experience of having designed, executed & completed complete electrical systems for STP's, inclusive of supply, installation and commissioning; on a single facility within India during the last five years and shall demonstrate capability and resources for integrating/interfacing with control systems from different manufacturers as well as coordination with multiple agencies for contract execution.

The agency shall demonstrate in house FAT facility with FAT simulation panel and other required hardware and software to conduct FAT as required under this contract. Agency shall submit documentation to validate the same as part of credentials submission.

The Agency on a minimum, shall have executed & completed at least ten individual STP contracts of minimum 10 MLD capacity for electrical system as required under this contract within India, during the last ten years period. Verification end user performance certificates shall be submitted for the same.

Note: In the event, if the OEM intends to execute (design, supply, program, execute and commission) the works, the OEM shall comply in full to the qualification criteria as required in this clause & specification.

The agency shall have an Electrical manager with minimum fifteen years of relevant experience and at least two team leaders with minimum seven years of relevant experience. The agency shall have minimum five number of design engineers with at least three years of relevant experience in design, installation and Commissioning of works similar to this contract and overall capacity and process. The engineers shall be on its permanent employment. Proof of ESIC/PF should be submitted to demonstrate the permanent employment. (Associate Employer Representatives/ Advisers/ consultants shall not be considered). The agency shall submit documentation and signed resumes of the personnel as part of credentials submission. The contractor and agency shall depute only approved personnel, who's resume has been approved.

### 12.19 HT Metal Enclosed Switchboard

| Sr. No. | | Description | Unit | Technical Particulars |
|---|---|---|---|---|
| 12.19.1 | | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| 12.19.2 | | Type | | As per Specification |
| 12.19.3 | | Applicable Standards | | As per Specification |
| 12.19.4 | | Quantity | No. | (*) |
| 12.19.5 | | **Switchgear cubicles and Bus bar ratings** | | |
| | (a) | Rated voltage, phases and frequency | | 11kV, 3 phase, 50 Hz<br>Resistance earthed |
| | (b) | System Neutral Earthing | | 12 |
| | (c) | Maximum system voltage | kV | |
| | (d) | One-minute power frequency withstand voltage | kV (rms) | 28 |
| | (e) | 12/50 μsec impulse withstand | kV (peak) | |

| Sr. No. | | Description | Unit | Technical Particulars |
|---|---|---|---|---|
| | | voltage | | 75 |
| | (f) | Short circuit withstand | | |
| | | (i) Short time (1 sec) at rated voltage | kA (rms) | 26.25 |
| | | (ii) Dynamic rating | kA(peak) | 65 |
| | (g) | Reference ambient temperature | | 45°C |
| | (h) | Maximum temperature of bus bars droppers' connectors and contacts at continuous current rating under site reference ambient temperature | | Joints, Silver faced : 100°C<br>Busbars and other joints : 85° C |
| | (i) | Continuous current rating of bus bar | A | (*) |
| | (j) | Bus bar material | | Copper |
| | (k) | Bus bar Insulation | | Fully insulated by encapsulation in epoxy resin with mould caps protecting all joints |
| | (l) | Cable entry | | Bottom |
| | (m) | Cable type for Incoming and Outgoing feeders | | 11kV (UE), XLPE Aluminium conductor with GI armouring |
| 12.19.6 | | **Switchgear constructional Requirement** | | |

| Sr. No. | | Description | | Unit | Technical Particulars |
|---|---|---|---|---|---|
| | (a) | Thickness of sheet steel Frame, Frame enclosures, doors, covers and partitions | | mm | Frame – 2.5min,<br>Doors/Covers/partitions – 2.0min |
| | (b) | Degree of protection | | | IP4X for panel enclosure & IP52 for metering compartment. |
| | (c) | Colour finish shade | | | Interior - Glossy white |
| | | | | | Exterior - Light grey semi-glossy shade 631 of IS:5 |
| | (d) | Earthing bus | i) Material | | Copper (run throughout the panel) |
| | | | ii) Size | mm x mm | (*) |
| | (e) | Earthing conductor | i) Material | | GS Flat |
| | | | ii) Size | mm x mm | (*) |
| 12.19.7 | | **Breaker Particulars** | | | |
| | (a) | Circuit breaker type | | | 3 pole, Vacuum draw out type, truck mounted with Surge Suppressor, trip free mechanism & anti pumping feature |
| | (b) | Voltage, phases and frequency | | | 12 kV, 50 Hz, 3 Ph |
| | (c) | Rated operating duty | | | O –0.3 sec. – CO – 3 min - CO |
| | (d) | Rated current at reference ambient temperature<br>(i) Incoming breakers | | A | (*) |

| Sr. No. | | Description | Unit | Technical Particulars |
|---|---|---|---|---|
| | | (ii) Outgoing breakers | A | (*) |
| | (e) | Rated breaking capacity | kA (rms) | 26.25 |
| | (f) | Rated making current | kA (peak) | 65 |
| | (g) | Short time current withstand for 1 sec duration | kA (rms) | 26.25 |
| | (h) | Total break time | | Less than 50ms |
| | (i) | Operating mechanism type (Normal) | | Motor spring Charged stored energy type for closing and tripping |
| | | Operating mechanism type (Emergency) | | Manual Spring Charged for closing and tripping |
| | (j) | Minimum no. of auxiliary contacts | | 6 NO+ 6 NC |
| | (k) | Withstand test voltage | | |
| | | (i) One-minute power frequency | kV (rms) | 28 |
| | | (ii) 1.2/50 μ sec impulse | kV (peak) | 75 |
| | (l) | Auxiliary control voltage<br>(i) For closing / tripping coil | | 110 V DC |
| | | (ii) For spring charging motor | | 240 V AC |
| | | (iii) For space heaters and lighting | | 240 V AC |
| | | (iv) Permissible variation in operating voltage of closing & tripping coils | | 85 to 110% for closing coil<br>70 to 110% for tripping coil |

| Sr. No. | | Description | Unit | Technical Particulars |
|---|---|---|---|---|
| | (m) | Anti-pumping feature | | To be provided |
| | (n) | Latching requirement | | Trip free |
| 12.19.8 | | **Current Transformers** | | |
| | (a) | Type | | Cast resin window type |
| | (b) | Class of insulation | | Class E or better |
| | (c) | Rated current ratio and burden<br>(i) Incomers and bus couplers | | (*) |
| | | (ii) Outgoing feeders | | (*) |
| | (d) | Accuracy class<br>(i) Metering | | 1.0 |
| | | (ii) Protection | | 5P20 and PS for core connected to Restricted Earth fault relay |
| | (e) | Short time 1 sec current rating | kA (rms) | 26.25 |
| | (f) | Dynamic rating | kA (peak) | 65 |
| 12.19.9 | | **Voltage Transformers** | | |
| | (a) | Type | | Cast resin |
| | (b) | Rated Voltage<br>(i) Primary | V | 11000/√3 |
| | | (ii) Secondary – S1 | V | 110/√3, 110/√3 |
| | (c) | Method of connection<br>(i) Primary – P | | Star, earthed |

| Sr. No. | | Description | Unit | Technical Particulars |
|---|---|---|---|---|
| | | (ii) Secondary – S1 | | Star, earthed |
| | (d) | Application – S1 | | Metering and protection |
| | (e) | Rated burden | VA | (*) |
| | (f) | Accuracy class | | Metering 1.0 |
| | | | | Protection 3P |
| | (g) | Rated voltage factor<br>(i) Continuous | | 1.1 |
| | | (ii) Short time | | 1.5 |
| | (h) | Insulation class | | Class E or better |
| 12.19.10 | (a) | **Meters**<br>Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| | (b) | Accuracy Class | | |
| | | (i) Indicating Meters | | Class 1.0 |
| | | (ii) Energy Meter | | Class 1.0 |
| 12.19.11 | | **Protective Relays** | | |
| | | Type | | Numerical Type |
| | | Auxiliary supply | | 110V DC |
| 12.19.12 | | **Annunciations** | | |
| 12.19.12.1 | | **Annunciations for Metal enclosed Switch board** | | |
| | (a) | Following alarm annunciation shall be provided on the 11kV Metal Enclosed Switchboard Incoming feeders | | |
| | | (i) Tripped on fault | | |

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| | (ii) O/C&E/F operated<br>(iii) Trip circuit supervision unhealthy | | |
| (b) | For each Outgoing transformer feeder circuit breakers<br>(iv) DC fail<br>(i) Tripped on fault<br>(ii) O/C&E/F operated<br>(iii) Buchholz, WTI, OTI trip<br>(iv) Trip circuit supervision unhealthy<br>(vi) DC fail<br>(v) AC fail<br>(vi) Buchholz, WTI, OTI, Oil level low alarms | | |
| (c) | For Other Outgoing feeders<br>(i) Tripped on fault<br>(ii) O/C&E/F operated<br>(iii) Trip circuit supervision unhealthy<br>(iv) DC fail<br>(v) AC fail | | |
| (d) | For Bus PT<br>(i) Under voltage trip<br>(ii) DC fail<br>(iii) AC fail | | |
| (e) | Spare windows : 2 Nos. Min. | | |

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.19.13 | **Cubicle Components** | | |
| | Each 11kV circuit breaker cubicle shall be provided with the following minimum standard accessories | | |
| (a) | One control switch 'trip-neutral-close' spring return to neutral position | | |
| (b) | One control selector switch 'Local-Off-Remote stay-put' type | | |
| (c) | LED Indicating lamps<br>(i) 'Red' for breaker in 'On' indication<br>(ii) 'Green' for breaker 'Off' position<br>(iii) 'Amber' for breaker tripped on fault 'White' for trip circuit healthy<br>(iv)'Red' for breaker in 'Service' position<br>(v) 'Clear' for breaker in 'Test' position<br>(vi) 'Blue' for breaker spring 'Charged'<br>(vii) 'Amber' for DC fail<br>(viii) 'Amber' for AC fail<br>(ix) 'Red', 'Yellow', 'Blue' for supply healthy for incomers.<br>(x) 'Ready to close' | | |
| (d) | Mechanical trip push button to trip the breaker when control supply is lost. The push button shall be shrouded type | | |
| (e) | One electrical anti-pumping relay | | |
| (f) | Double pole control supply MCB one each for AC & DC control supply | | |
| (g) | Cubicle space heater of adequate capacity with thermostat<br>240V, 1 Phase, 50Hz, 15/5A, 5 pin receptacle with switch | | |

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| (h) | Cubicle lamp with door interlock switch | | |
| 12.19.14 | **Auxiliary A.C. Supply** | | |
| | 240V, 1Ph, 50Hz supply shall be made available to each cubicle of 11kV Metal Enclosed Switchboards separately for provision of following by providing control transformer | | |
| (a) | Spring charging motor | | |
| (b) | Cubicle space heater with thermostat | | |
| (c) | Cubicle lamp | | |
| (d) | 240V, 1Ph, 50Hz 15/5A 5 pin receptacle with switch | | |

## 12.20 Distribution Transformers

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.20.1 | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| 12.20.2 | Type | | As per Specification |
| 12.20.3 | Applicable Standards | | As per Specification & IS 1180 |
| 12.20.4 | Rated output | kVA | (*) |
| 12.20.5 | Quantity required | Nos. | (*) |
| 12.20.6 | Transformer location | | Outdoor |
| 12.20.7 | No load transformer ratio | kV/kV | 11/0.433kV |
| 12.20. | Number of phases | | 3 |

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| 8 | | | |
| 12.20.9 | Rated frequency | Hz | 50 |
| 12.20.10 | Impedance at all taps<br>Standard losses | %<br>Watts | Value as per IS 1180<br>Latest Amendment-4 |
| 12.20.11 | Number of winding / materials of conductor / Insulation class | | Two/Copper/class A |
| 12.20.12 (a) | Method of connection<br>HV winding | | Delta |
| (b) | LV winding | | Star |
| 12.20.13 | Vector group | | Dyn11 |
| 12.20.14 | LV Neutral | | Solidly earthed |
| 12.20.15 | Type of cooling | | ONAN |
| 12.20.16 | Tap changer | | Full capacity, microprocessor base On-load type on HV side with local marshalling box and Remote Tap Changing panel |
| 12.20.17 | Tap range | % | + 5 % to -15 % |
| 12.20.18 | Tap step | % | 2.5 % |

| Sr. No. | Description | Unit | Technical Particulars | |
|---|---|---|---|---|
| 12.20.19 | Terminal connection | | | |
| (a) | HV terminals | | Cable box suitable to 11kV UE, XLPE, Al. Conductor, armoured cable of size (*) | |
| (b) | LV terminals | | Cable box suitable for 1100V XLPE, Al. Conductor armoured cables (*)<br>For transformer ratings greater than or equal to 1000kVA should be suitable for termination of Non-Segregated Aluminium Bus duct (*) | |
| 12.20.20 | Current Transformer | | | |
| (a) | On LV | | (*) | |
| (b) | On LV Neutral | | | |
| 12.20.21 | LV Neutral earthing | | LV Neutral shall be brought out through a 1.1kV rated bushing, both inside the cable box for forming the 3Ph, 4-wire system and outside the cable box for direct connections to earth by means of 25 x 3mm, GI earthing conductor (*) | |
| 12.20.22 | Insulation of Windings | | H.V. | L.V. |
| (a) | One-minute power frequency withstand voltage (dry and wet) | kV (r.m.s) | 28 | 3.0 |

| Sr. No. | Description | Unit | Technical Particulars | |
|---|---|---|---|---|
| (b) | 1.2/50 micro second full wave impulse withstand voltage | kV (peak) | 75 | - |
| 12.20.23 | Insulation of bushings | | H.V. | L.V. (Line and Neutral) |
| (a) | Rated Voltage of bushing | kV | 17.5 | 1.1 |
| (b) | One-minute power frequency withstand voltage | kV (r.m.s) | 38 | 3.0 |
| (c) | 1.2/50 microsecond full wave impulse withstand voltage | kV (peak) | 95 | - |
| (d) | Minimum creepage distance | mm | 25mm/kV on 17.5kV | 25mm/kV on 3kV |
| 12.20.24 | Vacuum withstand capability of transformer main tank with bushings, radiations, fitting and accessories. | | 250mm of mercury up to 200kVA, 500mm of mercury above 200kVA | |
| 12.20.25 | Inspection | | As per IS 1180, Complete Routine test and one each from Type test and Special test to be indicated in QAP for witness | |

## 12.21 415 V Metal Enclosed Switchgears (PCC) /MCC

| Sr. No | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.21.1 | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| 12.21.2 | Type | | As per Specification |
| 12.21.3 | Applicable Standards | | As per Specification |
| 12.21.4 | Quantity | No. | (*) |
| 12.21.5 | **415 V Switchgear and Busbar Ratings** | | |
| (a) | Rated voltage phase and frequency | | 415V, 3 Ph, 50 Hz |
| (b) | System Neutral Earthing | | Solidly earthed |
| (c) | Maximum system voltage | V | 476 |
| (d) | One-minute power frequency voltage | | |
| | i) Power circuits | V | 2500V (rms) |
| | ii) Control circuits | V | 1500V (rms) |
| | iii) Aux. Circuits connected to Sec of CTs | V | 1500V (rms) |
| (e) | Continuous current rating of Busbars under site reference Ambient Temperature and type & material | Rating<br>Material | (*)<br>Copper |
| (f) | Busbar insulation | | Fully insulated encapsulation in epoxy resin with moulded caps protecting all joints |
| (g) | Reference Ambient Temperature | ° C | 45 |

| Sr. No | Description | | Unit | Technical Particulars |
|---|---|---|---|---|
| (h) | Maximum Temperature of Busbars, Droppers and Contacts at Continuous current rating under site ambient temperature | | $^{o}$ C | 85$^{o}$ C for busbars and non-silver-plated joints |
| | | | | 100$^{o}$ C for silver plated joints |
| (i) | Short Circuit current withstand for Busbars and droppers<br>(i) Short time 1 sec | | kA (rms) | 50 |
| | (ii) Dynamic Rating | | kA (peak) | 125 |
| 12.21.6 | **Switchgear Constructional Requirement** | | | |
| (a) | Type of Construction | | | Single front fixed type (Except for air Circuit Breakers, which shall be draw out type). Construction features shall be as per specification. |
| (b) | Thickness of sheet steel<br>(i) Frame, Frame enclosures, doors, covers and partitions | | mm | CRCA– 2.0 |
| (c) | Degree of protection | | | IP 54 indoor and IP 65 for outdoor |
| (d) | Colour finish shade | | | Interior: Glossy white |
| | | | | Exterior: Light grey semi glossy Shade 631 of IS-5 |
| (e) | Earthing bus | Material | | Copper (run throughout the panel) |
| | | Size | mm x mm | (*) |
| (f) | Earthing | Material | | GS |

| Sr. No | Description | | Unit | Technical Particulars |
|---|---|---|---|---|
| | conductor | | | |
| | | Size | mm x mm | (*) |
| (g) | Minimum clearances in air of live parts<br>(i) Phase to Phase | | mm | 25.4 |
| | (ii) Phase to Earth | | mm | 25.4 |
| (h) | (i) Cable entry<br>(ii) Cable entry for panels above wet well | | | Bottom<br>Top |
| 12.21.7 | **Instrumentation Transformers** | | | |
| (a) | Current transformer | | | |
| | (i) Ratio | | | (*) |
| | (ii) Burden | | VA | (*) |
| | (iii) Accuracy Class | | | 1.0 |
| (b) | Voltage transformer | | | |
| | (i) Ratio | | | (415V/ √3) / (110V/ √3) |
| | (ii) Burden | | VA | 50 |
| | (iii) Accuracy Class | | | 1.0 |
| (c) | Auxiliary A.C. Supply | | | 240V, 1Ph, 50Hz supply shall be made available to each cubicle of 415V Metal Enclosed Switchboards separately by providing control transformer |

## 12.22 Power Capacitor and Control Panel

| Sr. No | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.22.1 | **General** | | |
| (a) | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| (b) | Type | | As per Specification |
| (c) | Applicable Standards | | As per Specification |
| (d) | Quantity | No. | (*) |
| (e) | Rated Capacity | KVAR | (*) |
| (f) | Rated supply voltage | V | 415 |
| (g) | Rated frequency and phases | | 50Hz, 3Phase |
| (h) | Reference Ambient temperature | ° C | 45 |
| (i) | Cable gland required | | Yes |
| (j) | Type of cable | | 1.1kV, XLPE, Al. Conductor |
| (k) | Size of cable | | (*) |
| (l) | Cable entry | | Bottom |
| 12.22.2 | **Constructional Requirement** | | |
| (a) | Thickness of sheet steel<br>i) Frame, Frame enclosures, doors cover and partition | mm | CRCA 2.0 |
| (b) | Degree of protection | | IP 42 |
| (c) | Colour finish shade | | Interior: Glossy white |
| | | | Exterior: Light Grey Semi Glossy Shade 631 of IS-5 |
| (d) | Main busbars and size | | Copper and (*) |
| (e) | Maximum Temperature of Busbars, Droppers and Contacts at Continuous | ° C | 85° C for busbars and non-silver-plated joints 100° C for non-silver- |

| Sr. No | Description | | Unit | Technical Particulars |
|---|---|---|---|---|
| | current rating under site ambient temperature | | | plated joints |
| (f) | Earthing bus | Material | | Copper (run throughout the panel) |
| | | Size | mm x mm | (*) |
| (g) | Earthing conductor | Material | | GS |
| | | Size | mm x mm | (*) |
| 12.22.3 | **Design Requirement** | | | |
| (a) | Insulation level | | kV (rms) | 3.0 |
| (b) | Capacitor bank connection | | | Delta |
| (c) | Short circuit withstand for busbars<br>i) Short time (1 sec) | | kA (rms) | 50 |
| | ii) Dynamic | | kA (peak) | 125 |
| (d) | Type of switching | | | Automatic switching responsive to power factor through power factor sensing relay |
| (e) | Switching steps | | | Minimum 8 steps |
| (f) | Switch and Rating of contactor | | | To suit kVAR of unit (switching duty) |
| (g) | Incomer MCCB current rating | | | To suit rated capacity of capacitor banks (switching duty) |
| (h) | O/L capacity of capacitors | | | 30% of rated capacity as per IS |
| (i) | O/V capacity of capacitors | | | 10% of rated voltage as per IS |

| Sr. No | Description | Unit | Technical Particulars |
|---|---|---|---|
| (j) | Protections | | O/V, U/V and O/L |

**12.23 Diesel Standby Generator Sets**

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.23.1 | **General** | | |
| (a) | Set Manufacturer | | |
| (b) | Type | | Silent Set with AMF |
| (c) | Sound Level at 1 metre distance | | < 75 dB |
| 12.23.2 | **Alternator** | | |
| (a) | Manufacturer | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| (b) | Type | | Salient pole, Revolving field, Brushless type |
| (c) | Rating | kVA | (*) |
| (d) | Voltage V | | 415 |
| (e) | Frequency Hz | | 50 |
| (f) | Overload Capacity | | 10% overload for 1 hour in any 12 hours |
| (g) | Insulation | | Class H with Class F temperature rise |
| (h) | Short circuit current | | 3 times full load current for 10 sec |
| (i) | Degree of protection | | IP 23 with IP 54 for terminal box |
| (j) | Current A | | (*) |

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| | | | |
| (k) | Power Factor | | 0.8 |
| 12.23.3 | **Diesel Engine** | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| (a) | Manufacturer | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| (b) | Type | | Four stroke, direct injection, turbocharged |
| (c) | Rating | KW | (*) |
| (c) | Speed | rpm | 1500 |
| (d) | Fuel Specification | | As per manufacturer's standard |
| (e) | Overload Capacity | | 10% overload for 1 hour in any 12 hours |
| (f) | Class of governance | | Class A2 |
| 12.23.4 | Day oil tank capacity with all necessary connections for fuel flow from day tank to DG engine with level sensors, inlet, outlet piping with valves and accessories etc. Complete | Litres | 990<br><br>(DG Set rating less than 200kVA fuel storage shall require to run minimum 10 hours continuously) |

## 12.24 Variable Frequency Drives

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.24.1 | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |

| | | | |
|---|---|---|---|
| 12.24.2 | Type of Drive | | Inverter Controlled A.C Drives |
| 12.24.3 | Rated voltage, frequency and phases | | 415V, 50Hz, 3Phase |
| 12.24.4 | Variation in voltage | | 415V $\pm$ 10 |
| 12.24.5 | Variation in frequency | | 50Hz $\pm$ 5 |
| 12.24.6 | Type of Duty | | 100% continuous, 150 % overload for 2 minutes once in period of 24 hours, 200 % overload for 10 seconds once in period of 24 hours |
| 12.24.7 | Design Ambient Temperature | | $45^0$C |
| 12.24.8 | Overall Harmonic Limitation (THDi) | | Less than 5% (including current and voltage harmonics) |
| 12.24.9 | Application | | As per Clause 12.14.4 of Part 12–Particular Electrical Plant Requirements |
| 12.24.9.1 | Interfaces | | Serial / Profibus |

**12.25 Battery**

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.25.1 | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| 12.25.2 | Type of battery | | Ni-Cd |
| 12.25.3 | Applicable Standards | | As per Specification |
| 12.25.4 | Number of battery banks required | | (*) |
| 12.25.5 | Ambient conditions | | Min. Temp. 25˚ C |

| | | | |
|---|---|---|---|
| | | | Max. Temp 45˚ C |
| 12.25.6 | D.C. system voltage | V | 110 ±10% |
| 12.25.7 | Ampere hour capacity of battery at 27 Deg. C at 5-hour rate to give final cell voltage of 1.16 volts/cell | Ah | As per the Requirement |
| 12.25.8 | Momentary load/duration | A | To be furnished by the Bidder |
| 12.25.9 | Emergency load/duration | A | |
| 12.25.10 | Continuous load/duration | A | |
| 12.25.11 | Nominal voltage | V | 1.2 V per cell |
| 12.25.12 | Cell voltage - initial/final | V | 1.42/1.14 V |
| 12.25.13 | Number of cells per bank required to give rated voltage | Nos | (*) |
| 12.25.14 | Number of spare cells per bank | Nos | (*) |
| 12.25.15 | Mounting arrangement | | Multi tier |
| 12.25.16 | Charging method | | Float cum boost charging |

## 12.26 Battery Charger

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.26.1 | **General** | | |
| (a) | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| (b) | Applicable Standards | | As per Specification |
| (c) | Type | | Float and Float cum Boost Charge |

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| (d) | Number required | Nos | (*) |
| (e) | Rated Output voltage (DC) | V | 110 |
| (f) | Rated Output | kW | (*) |
| (g) | DC System Earthing | | Unearthed |
| (h) | Voltage regulation from no load to rated load | % | ± 1 |
| (i) | Ambient Design Temperature | Deg C | 45 |
| (j) | **AC ripple in DC output voltage at rated continuous load** | | Less than 1% |
| (k) | **Type of rectifier** | | SCR, full wave fully controlled |
| (l) | **Transformer** | | Copper double wound dry type with class-F insulation |
| (m) | Float/Trickle charging current<br><br>of battery | mA | As per manufacturer |
| (n) | Boost Charging Current of Battery (Maximum) | A | As per manufacturer |
| (o) | Boost Charging Voltage of Battery (maximum) | V | As per manufacturer |
| (p) | Maximum Time for Boost charging<br><br>of Battery | hr | As per manufacturer |
| 12.26.2 | **Battery Details** | | |
| (a) | Float/Trickle charging current<br><br>of battery | mA | As per manufacturer |
| (b) | Boost Charging Current of | A | As per manufacturer |

| Sr. No. | Description | | Unit | Technical Particulars |
|---|---|---|---|---|
| | Battery (Maximum) | | | |
| (c) | Boost Charging Voltage of Battery (maximum) | | V | As per manufacturer |
| (d) | Maximum Time for Boost charging of Battery | | hr | As per manufacturer |
| (e) | Battery capacity & no. of cells | | Ah | (*) |
| | | | Nos. | (*) |
| 12.26.3 | **AC System Data** | | | |
| (a) | Supply | Voltage | V | 415 |
| | | Phase | | 3 |
| (b) | (i) Variation in supply Voltage | | % | ± 10 |
| | (ii) Variation in supply frequency | | % | ± 5 |
| (c) | Short Circuit level | | kA | 50 |
| (d) | Type of earthing | | | Solidly Earthed |
| 12.26.4 | **Performance** | | | |
| (a) | DC voltage setting adjustment for float charger | | | ±10% of nominal voltage |
| (b) | Voltage stabilisation for constant voltage regulator | | | ±1% of set D.C. voltage, with AC input variation and DC load variation from 0 to 100% |
| (c) | Maximum permissible variation | | | ± 1% |

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| | in DC voltage (no load to full load) | | |
| (d) | D.C. voltage setting adjustment<br>for boost charging | | 70% to 100% of max. boost charging voltage |
| (e) | D.C. current adjustment for boost<br>Charging | | 30% to 100% of max. boost charging current |
| (f) | Current stabilisation for constant<br>current regulator for boost charger | | ± 2% |
| (g) | Minimum permissible power factor<br>to rated continuous load | | 0.8 |
| (h) | Permissible ripple content at rated<br>continuous load | | 3% (maximum) |
| (i) | Relay for auto changeover from Float to boost mode to be provided (in case of float-cum-boost charger) | | Yes |
| 12.26.5 | **Constructional Features** | | |
| (a) | Thickness of sheet steel Frame, Frame enclosures, doors, covers and partition | mm | Cold rolled 2.0 |
| (b) | Degree of protection | | IP 42 |
| (c) | Colour finish shade | | Interior: Glossy white |
| | | | Exterior: Light Grey Semi Glossy Shade 631 of |

| Sr. No. | Description | | Unit | Technical Particulars |
|---|---|---|---|---|
| | | | | IS 5 |
| (d) | Earthing bus | Material | | Copper |
| | | Size | mm x mm | (*) |
| (e) | Earthing conductor | Material | | GS |
| | | Size | mm x mm | (*) |
| (f) | Cable entry | | | Bottom |
| (g) | Cable Sizes<br>(i) Battery | | sq.mm | (*) |
| | (ii) DC output | | sq.mm | (*) |
| | (iii) AC input | | sq.mm | (*) |

**12.27 DC Distribution Board**

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.27.1 | **General** | | |
| (a) | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| (b) | Applicable standards | | As per specification |
| (c) | Quantity | Nos | (*) |
| (d) | DC System voltage (Nominal) | V | 110 |
| (e) | DC System Earthing | | Unearthed |
| (f) | Ambient Design Temperature | Deg. C | 45° C |
| (g) | Busbar material, rating and | | Copper, Rating & Size |

| | | | |
|---|---|---|---|
| | size | | (*) |
| 12.27.2 | **DC Bus Load** | | |
| (a) | Total continuous DC load | A | (*) |
| (b) | Short time loads (Additional to continuous loads) | | |
| | (i) DC lights/Facia lamps | A | (*) |
| | (ii) Starting current and duration of Largest Connected DC Motor | A | (*) |
| | | Secs | (*) |
| 12.27.3 | **Constructional Features** | | |
| (a) | Thickness of sheet steel Frame, Frame enclosures, doors, covers and partition | mm | CRCA 2.0 min. |
| (b) | Degree of protection | | IP 54 |
| (c) | Colour finish shade | | Interior: Glossy white |
| | | | Exterior: Light Grey Semi Glossy Shade 631 of IS 5 |
| (d) | Earthing bus — Material | | Copper (run throughout the panel) |
| | Size | mm x mm | (*) |
| (e) | Earthing conductor — Material | | GS |
| | Size | mm x mm | (*) |
| (f) | Cable entry | | Bottom |
| (g) | Cable Sizes (i) DC Input from Battery | sq.mm | (*) |
| | (ii) DC output to Load | sq.mm | (*) |

## 12.28 Cables

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.28.1 | **11kV (UE) XLPE Insulated Power Cables** | | |
| (a) | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| (b) | Applicable Standards | | As per specification |
| (c) | Cable size selection | | As per requirement |
| (d) | Continuous current rating with cable laid in air/ ground under specified ambient temperature | A | (*) |
| (e) | Conductor material | | Stranded, aluminium, EC grade/class-2 |
| (f) | Conductor screening | | Semiconducting compound by extrusion |
| (g) | Insulation | | Extruded XLPE |
| (h) | Screening on Insulation | | Semiconducting compound by extrusion (non-metallic), copper tape (metallic) |
| (i) | Identification of codes | | By providing strip of Red, Yellow & Blue colours |
| (j) | Inner sheath | | Extruded PVC, type ST-2 |
| (k) | Filler material | | PVC |
| (l) | Armouring | | Galvanised steel flat strip |
| (m) | Outer sheath | | Extruded PVC, type ST-2 |
| (n) | Overall diameter of cable | | To be furnished by the Bidder |

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| (o) | Recommended minimum bending radius | mm | To be furnished by the bidder |
| (p) | Standard length of cable on each drum | mts | (*) |
| **12.28.2** | **1100V Grade XLPE Insulated Power Cables** | | |
| (a) | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| (b) | Applicable Standards | | As per specification requirement |
| (c) | Cable size selection | | As per specification |
| (d) | Conductor material | | Stranded, aluminium/copper, EC grade |
| (e) | Insulation | | XLPE |
| (f) | Inner sheath | | Extruded PVC, type ST-2 |
| (g) | Armouring | | Galvanised steel flat strip/round wire |
| (h) | Outer sheath | | Extruded PVC, type ST-2 |
| (i) | Overall diameter of cable | | To be furnished by the Bidder |
| (j) | Recommended minimum bending radius | mm | To be furnished by the bidder |
| (k) | Standard length of cable on each drum | mtrs | (*) |
| **12.28.3** | **650/1100V Grade PVC Insulated Control Cables** | | |

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| (a) | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement |
| (b) | Applicable Standards | | As per specification |
| (c) | Rated voltage | V | As per requirement |
| (d) | Cable size selection | | As per specifications requirement |
| (e) | Conductor material | | Stranded, copper, EC grade |
| (f) | Insulation | | PVC |
| (g) | Inner sheath | | Extruded PVC, type ST-1 |
| (h) | Armouring | | Galvanised steel round wire |
| (i) | Outer sheath | | Extruded PVC, type ST-1 |
| (j) | Standard length of cable on each drum | mts | (*) |

## 12.29 Lighting Fixtures and Accessories

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.29.1 | **General** | | |
| (a) | Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| (b) | Type | | As per specification |

| **Sr. No.** | **Description** | **Unit** | **Technical Particulars** |
|---|---|---|---|
| (c) | Illumination levels at various premises | | As per Building Services, Clause 12.16 of Part 12-Particular electrical requirements |
| (d) | Normal supply voltage, phase and frequency | AC | 240V, 1Ph, 2 wire, 50Hz |
| | | DC | 110V, 2 wire, unearthed |
| (e) | Variation in supply: | | |
| | (i) Voltage (AC & DC) | % | ± 10 |
| | (ii) Frequency | % | ± 5 |
| | (iii) Combined voltage & frequency | % | ± 10 |
| (f) | Design ambient air temperature | $^0$C | 45˚ C |
| 12.29.2 | Luminaire terminal suitable for | | |
| (a) | Indoor area | | |
| | (i) Conductor material | | Copper |
| | (ii) Cable size | Coresxm $m^2$ | (*) |
| (b) | Outdoor area | | |
| | (i) Conductor material | | Copper |
| | (ii) Cable size | Cores x$mm^2$ | (*) |
| 12.29.3 | Luminary earthing terminal suitable for | | |
| | (i) Conductor material | | G. S. wire |
| | (ii) Conductor size | SWG | (*) |

## 12.30 Lighting System and Equipment

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| 12.30.1 | **System Particular** | | |
| (a) | **Voltage** | | |
| | (i) 3 Phase, 4 wire 50 Hz system | | |
| | • Rated | V | 415 |
| | • Maximum | V | 476 |
| | • One minute withstand voltage | | 2500 V AC. |
| | (ii) D.C. system | | |
| | • Rated | V | 110 |
| (b) | System short-circuit level | | |
| | (i) At 415 V, A.C. | kA (rms) | 10 |
| | (ii) At 110 V.D.C. | kA (D.C.) | 6 |
| (c) | Reference ambient temperature | $^0$ C | 45$^0$ C |
| 12.30.2 | **Distribution Board/Panels** | | |
| (a) | Main, floor mounted distribution boards | | |
| (i) | Main Lighting distribution board (A.C.) | | |
| | • Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| | • Type | | Floor standing, sheet steel Enclosed |

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| | • Degree of protection | | IP 54 |
| | • Busbar material | | Copper |
| | • Busbar current rating | A | (*) |
| | • Short circuit current rating | kA | (*) |
| | • Cable entry | | Based on Layout Top or bottom |
| | • Location | | Indoor |
| (ii) | Emergency lighting panel (D.C.) | | |
| | • Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| | • Type | | Wall mounting, sheet steel Enclosed |
| | • Degree of protection | | IP 54 |
| | • Busbar material | | Copper |
| | • Busbar current rating | A | (*) |
| | • Short circuit current rating | kA | (*) |
| | • Cable entry | | Based on Layout Top or bottom |
| | • Location | | Indoor |
| (iii) | Single phase DBs, wall/structure mounting | | |
| | SLDB for indoor area | | |
| | • Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |

| Sr. No. | Description | Unit | Technical Particulars |
|---|---|---|---|
| | • Type | | Wall mounting, sheet steel enclosed |
| | • Degree of Protection | | IP 54 |
| (iv) | SLDB for outdoor area | | |
| | • Make | | As per Preferred Makes/ Manufacturers of Part-6, General requirement. |
| | • Type | | Wall mounting, sheet steel enclosed |
| | • Degree of Protection | | IP 65 |
| (v) | Paint Finish | | |
| | (i) Colour shade: | | Interior: Glossy white |
| | | | Exterior: Light gray semi glossy shade 631 of IS:5 |
| 12.30.3<br><br>(a) | **Street Light Poles and Flood Light Poles**<br><br>Street Light Pole single arm | | |
| | Total Height: | m | 7.5 |
| | Quantity: | Nos. | (*) |
| (b) | Floodlight Light Pole | | |
| | Total height: | mts. | 9 |
| | No. Of floodlights to be fixed per pole | No. | (*) |

## 12.31 Earthing and Lightning Protection System

| Sr. No. | Description | Technical Particulars | | |
|---|---|---|---|---|
| | | **Size** | **Material** | **No. of Leads & Quantity** |
| 12.31.1 (a) | **Main Earthing Grid** Buried in earth | (*) | MS | Quantity as per requirement |
| (b) | Buried in floor slabs in buildings | (*) | MS | Quantity as per requirement |
| 12.31.2 | **Conductor Leads to Equipment** (above ground) | | | Number of Leads As per relevant Standards, Quantity as per requirements |
| (a) | Transformers | | | |
| (i) | Transformer neutral to bottom of tank | (*) | GS | |
| (ii) | From bottom of tank to earth grid | (*) | GS | |
| (iii) | Transformer tanks and radiator bank | (*) | (GS | |
| (b) | Diesel Generator Set | | | |
| (i) | DG Set neutral earthing | (*) | GS | |
| (ii) | DG Set body earthing | (*) | GS | |
| (c) | Fence posts and gates (Flex. braid) | (*) | GS | |
| 12.31.3 | 11kVMetal Enclosed Switchboard, 415Vswitchgear/ MCC. | (*) | GS | |

| Sr. No. | Description | Technical Particulars | | |
|---|---|---|---|---|
| 12.31.4 | Motors | | | |
| (a) | 415V Motors above 10 kW | (*) | GS | |
| (b) | 415V Motors up to 10 kW | (*) | GS | |
| (c) | Fractional horse power motors | (*) | GS | |
| 12.31.5 | **Other Items** | | | |
| (a) | Capacitor panel, Battery charger panel, DC distribution board, Main lighting D.B, Control panels and sub-lighting distribution boards | (*) | GS | |
| (b) | Hand Rails | (*) | GS | |
| (c) | Cable trays | (*) | GS | |
| (d) | Tanks | (*) | GS | |
| (e) | Junction boxes | (*) | GS wire | |
| (f) | Lighting fixtures, receptacles, lighting conduits | (*) | GS wire | |
| (g) | Push button stations, limit switches | (*) | GS wire | |
| 12.31.6 | **Crane rail** | (*) | GS | |
| 12.31.7 | Street lighting, flood lighting poles and junctions' boxes | (*) | GS | |
| 12.31.8 | Metallic non-current carrying structures | (*) | GS | |

| Sr. No. | Description | Technical Particulars | | |
|---|---|---|---|---|
| 12.31.9 | **Lightning Conductors** | | | |
| (a) | Lightning protection down comers for building | (*) | GS | |
| (b) | Lightning protection horizontal roof conductor for building | (*) | GS | |
| 9.31.10 | **Electrodes** | (*) | Heavy duty 40mm diameter GI pipe 3000 mm long | Quantity as per requirements |
| (a) | Pipe electrode | (*) | | |

Note: Any requirement / features / provisions not specifically mentioned in the Specification but are necessary for trouble free and smooth operation of the Plant System shall be included.

(i) (*) – The numbers, ratings, sizes etc shall be worked out by the contractor during execution and to be approved by the Engineer.

(ii) Contractor shall notify the Employer for factory inspection and testing of equipment as defined in Clause 14.1.2, Materials, Plant & Equipment of Part 14, Volume -2 of the Bid document.

**End of Part-12**